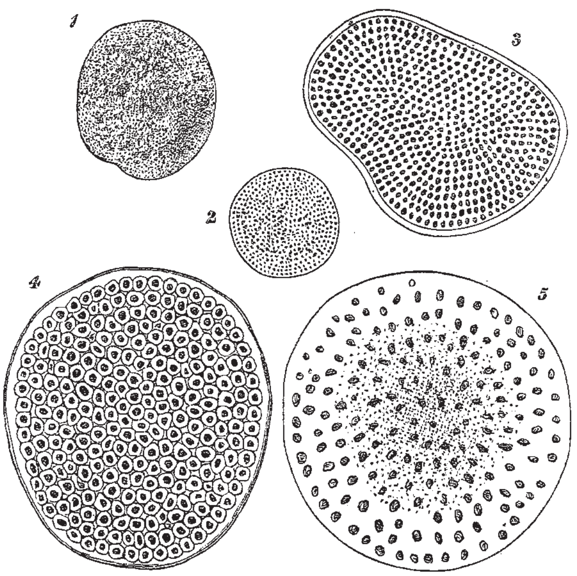
ON THE CLASSIFICATION OF THE VEGETABLE KINGDOM[1]

I.

CLASSIFICATION is a natural propensity of the human mind. If our attention finds itself directed to a large number of objects, about which we desire to inform ourselves, a desire to economise our labour, or even render it possible, at once leads us to endeavour to throw the assemblage into subordinate groups. The result, and indeed end, of this process is to enable us to frame general statements about these groups which cover all the things comprised within them. In the case of a naturalist it is desirable that the groups should be so constituted as to admit of as many general statements as possible being made with regard to them; and in proportion as our classification allows us to do this successfully, we say it is a natural one—one conformable to the order of nature—and such as nature herself would indicate if the task were assigned to her rather than undertaken by us.

The question, however, immediately arises, What is the cause which brings about this possession of common characters by each member of a group of organisms, and renders their natural classification possible? We are now able to answer with a very high degree of probability of the explanation being the true one, "that propinquity of descent—the only known cause of the similarity of organic beings—is the bond, hidden as it is by various degrees of modification, which is partially revealed to us by our classifications."[2]



FIGS. 1–5.—Development of colonies of *Bacterium rubescens* after Lankester ("Quart. Journ. Micr. Soc.," 1876, Plate III).

The earliest attempts at classification seized upon the most striking superficial distinctions. When Solomon "spake of trees from the cedar tree that is in Lebanon, even unto the hyssop that springeth out of the wall," it is quite evident that mere *size* was the point of comparison which aided the process of passing them under review. And till the time of Ray and the beginning of the eighteenth century the classification of plants into trees, shrubs, under-shrubs, and herbs held its ground, though nothing is now better understood than that size, which is a mere matter of habit and mode of growth, is no clue at all to the real affinities of plants. It is easy to see in point of fact when we have once grasped the principle of descent as the cause of resemblances, that those characters which are most valuable for classificatory purposes, are generally those which are least prominent. From age to age organisms may vary in response to the changes of the external conditions to which they are exposed. Nevertheless, underlying the most manifold modifications, some apparently insignificant detail of structure or development will be handed on unchanged, because it has never happened to conflict with the stress of existence, and such a detail will reveal the story of relationship which the comparison of more striking, but really less essential (because *adaptive*) external modifications would perhaps completely obscure.

Thus, comparing the two great departments of activity, into which the life of plants is divisible—nutrition, *i.e.*, all that concerns the growth or multiplication of the *same* individual, and reproduction, *i.e.*, all that concerns the production of a *new* individual, while characters drawn from nutritive structures (such as branching and texture of stems, form of leaves, &c.), have proved of little value, those taken from reproductive structures have proved of the highest importance for purposes of classification. And the reason is that a plant must live before it can reproduce. The stress of competition is harder on the nutritive side of its life than on the reproductive. Habit of growth, which is the expression of the plant's attempt to adapt itself to the conditions of existence prescribed to it, must vary as the conditions vary;

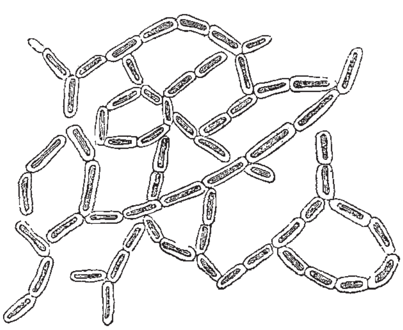


FIG. 6.—Zooglœa stage of *Bacterium rubescens* after Lankester ("Quart. Journ. Micr. Soc.," 1873, Plate XXIII.).

but the development of ovules and homologous organs comes when the battle of life, so to speak, is won. Their details of structure, and the development of the embryo-plants which proceed from them are, at any rate, in a great measure relieved from the necessity of undergoing adaptive changes. They undergo, no doubt, progressive modifications, but these are comparatively slow and are perhaps brought about in part by the correlation of growth, which causes a changing part of an organism to effect alterations in other parts which are not at first implicated in or directly benefited by the original modification, and yet cannot help participating in it because the organism must alter more or less as a whole.

Thus, then, as amongst human beings, whether we consider the family or the race, similitude or family likeness implies blood-relationship or community of descent; in all organisms resemblances in structure which are constant in large groups or vary very slowly, imply origin from a common ancestor. The real problem of classification is nothing less than to group organisms as we should see them grouped if we could inspect the mighty family trees of the plant or animal worlds. This mode of regarding the facts of natural history is termed phylogeny.

In undertaking the actual task of classification, we proceed on the assumption that as in a tree the twigs which form the growth of any one year belong to branches of all ages—from the very earliest to the very youngest—the

[1] Notes of four lectures delivered at the Royal Institution during February and March.
[2] Darwin, "Origin of Species," 4th Ed. p. 489.

living constituents of the vegetable kingdom represent, more or less modified, various successive grades of development which plants have passed through. Some of the branches of the family tree have now no living representatives, and as to these we must seek for such evidence as palæontology affords us. To trace out the family tree in all its details must obviously be always a matter of extreme difficulty, and may never be completely possible. Our present information does not extend to much more than

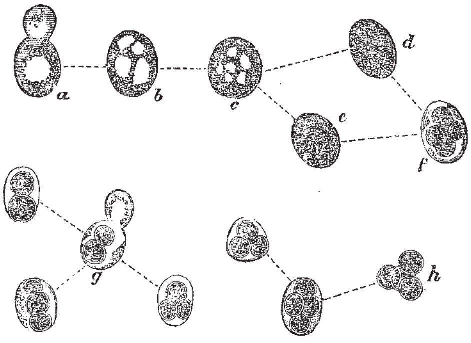


FIG. 7.—Successive stages in development of spores of yeast (after Reess).

a knowledge of the closely-packed exterior formed by the ultimate twigs. We cannot see very far how these pursue their course, nor get more than an approximate notion of the way in which the main branches are given off. Clearly, however, we may assume that organisms have in the main proceeded from simple and generalised forms to those which are specialised and complex. The simpler existing plants will therefore be the representatives of the oldest forms of all.

As long ago as 1836 Endlicher divided the vegetable kingdom into Thallophyta (leafless plants) and Cormophyta (leafy plants). The one exhibits the presence, and the other, if we may say so, the absence of the contrast of leaf and stem. Leafless plants are clearly the simpler, and come nearer, therefore, the base of the family tree.

Now Thallophyta have long been held to fall into two great groups—*Algæ* (tangles), which, speaking generally, are independent of organic nutriment, contain chlorophyll, and build up the materials of their tissues from inorganic materials; *Fungi* (thread-plants), on the other hand, are wholly dependent on other organisms, which they feed on, either living or in decay. Each series ranges from the very simplest forms which it is possible to conceive endowed with life, up to others which display a very complicated structure. Nevertheless there is a remarkable structural parallelism between them, and it

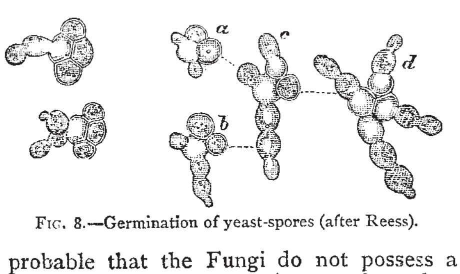


FIG. 8.—Germination of yeast-spores (after Reess).

seems probable that the Fungi do not possess a continuous line of descent of their own, but that they are an assemblage of reduced or degraded forms which have abandoned the business of food-manufacture, and appropriate their nutriment more or less ready made, and which correspond to different points in the line of descent of Algæ. *Thallophyta*, therefore, disregarding the cross division into Algæ and Fungi may be classified after Sachs,[1] and mainly according to their reproductive processes into four classes:—1. Protophyta; 2. Zygosporeæ; 3. Oosporeæ; 4. Carposporeæ.

PROTOPHYTA consist of excessively minute plants only visible to the naked eye when aggregated together in considerable masses. They consist of minute particles of protoplasm often no larger than a human red blood-corpuscle or much smaller, which are usually invested with a covering of cellulose, sometimes, however, very hard to distinguish. The protoplasm is homogeneous and without a denser portion or nucleus, but may contain minute particles, and even watery globules. It is either quite colourless or contains chlorophyll more or less masked with other colouring matters. Multiplication is effected by the fission or bi-partition of the protoplasm of one individual or cell. This frequently takes place in a single direction only, so that the new individuals more or less adhere together in a linear series. The cellulose investment or cell-wall is apt to pass by the absorption of water into a gelatinous condition, which may even form a kind of matrix in which the individual cells seem to be imbedded. Two groups deserve especial attention, *Schizomycetes* and *Saccharomycetes*. Both are destitute of chlorophyll, and so are dependent for their nutriment on materials elaborated by other organisms. In obtaining what they want they set up incidental chemical changes and decompositions. Thus Bacteria bring about *putrefaction* in fluids containing nitrogenous matters, and yeast produces *fermentation* in saccharine solutions.

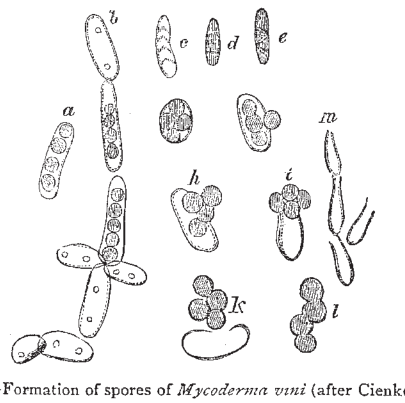


FIG. 9.—Formation of spores of *Mycoderma vini* (after Cienkowski).

When any fluid capable of undergoing putrefaction is exposed to the air at a temperature of about 30° C., it speedily loses its clearness and becomes turbid and milky. This is usually due in the case of vegetable infusions to the presence of immense numbers of a minute organism known as *Bacterium Termo*. Other forms are, however, met with, and according to the nature of the fluid, one or other seems to get the upper hand and predominate. They vary in shape from a mere rounded speck ($\frac{1}{30000}$ in. in diameter) to elongated rod-like bodies sometimes rolled into a short spiral. The rod-like forms exhibit free movements which in the larger are obviously due to the presence of a cilium at each extremity, and are probably so in all.

The life history of the Bacteria is still imperfectly known. One striking kind has been studied from macerating pans by Prof. Lankester. It exhibits a great variety of forms, but all are tinged with a peculiar purple pigment, and it seems probable, therefore, that they all belong to the same species, and that the different phases are due to diversities in the condition of development or culture. This, if true, would apply to other series of forms which are colourless or tinged with other pigments. In one condition the Bacterium is in a kind of resting condition (Fig. 1), and is a mere microscopic spherule of protoplasm. This gradually granulates (Fig. 2),

[1] Lehrbuch der Botanik, 4th ed., pp. 248, 249.

and the protoplasm aggregating about the new centres, the spherule by successive stages (Figs. 3-5) reaches a condition in which it forms an assemblage of individuals held together by their gelatinous investments. These aggregates break up, and the individuals disperse. Their subsequent degree of elongation varies, but a biscuit-shaped form is a common one. Like other Bacteria they divide repeatedly, and ultimately accumulate in masses at the bottom of the fluid or on the surface in reticulated arrangements (Fig. 6), which are sufficiently permanent from the adhesion of their gelatinised coats (Zooglœa stage). The parallelism which these processes possess with those of higher forms of Algæ will be alluded to hereafter. The whole of the *Schizomycetes* or *Bacteria* appear to be reduced representatives of the *Oscillatorieæ*, a group of Protophyta which possess the chlorophyll which Schizomycetes have lost. They have, in addition, a peculiar bluish tint, and this may be recognised in Bacterium Termo.

The *Saccharomycetes* must be dismissed very briefly. Yeast (*Saccharomycetes cerevisiæ*), consisting of pale spherical cells about $\frac{1}{3000}$ in. in diameter, is the type of the group, and multiplies, not like Bacteria, by fission, but by the budding out of new individuals from different points of the parent cell, these often forming a short chain by repetition of the process, but being subsequently detached by constriction. Under conditions unfavourable to growth, as when the yeast is cultivated on slabs of moist plaster of Paris, beside growth by external extension, there is also a process of internal segmentation of the protoplasm (first observed by Reess). These two modes of reproduction may be compared to the two which take place in *Bacterium rubescens*. The latter of these in the case of yeast results (Fig. 7) in the massing of the protoplasm into four spores which are finally set free by the disruption of the parent cell-wall. They germinate when put into a favourable fluid, and reproduce chains (Fig. 8).

The ferment of wine (*Mycoderma vini*), besides other points of difference, produces cylindrical instead of spherical cells. These also give rise to spores (Fig. 9) by internal segmentation. W. T. THISELTON DYER

(*To be continued.*)

METEOROLOGY IN JAPAN [1]

EACH of the numbers of Mr. McVean's publication gives the tri-daily observations of the various meteorological elements for five days, beginning with December 2, 1875, with the means and extremes for each of the five-day periods. The observations and reductions of each sheet have been made with great fulness and discrimination, and we hope Mr. McVean will soon be in a position to extend his system of observation to more places than Tokei, so as to give the data for the determination of the meteorology of Japan, which, from its relations to the continent of Asia and ocean currents, presents many points of great and peculiar interest.

The data discussed in Staff-Commander Tizard's "Contribution to the Meteorology of Japan" have not been obtained through the observing staff of the *Challenger*, but from records lent by the Superintendent of Japanese Lighthouses and Buoys. They consist of observations of the barometer, thermometer, rain-gauge, wind and weather, as made at twelve lighthouses, two lightships, and at Yedo, the monthly averages of which are represented on four diagrams. The barometric and wind results are besides shown, by isobars and arrows, on twelve small maps for the different months of the year. The Meteorological Committee publish, as an appendix to the paper, six closely-printed pages of tabular matter, giving the results of observations made in the seas of China and Japan, deduced from registers kept for the Meteorological Office.

The winds are, perhaps, the most valuable part of the paper, as showing the variations of wind with season at different places on the coast; they are, moreover, in general accordance with what was previously known of the meteorology of Japan. The rain results are interesting, but they would have been more valuable if the position of the gauges had been stated. From the necessarily faulty position of the thermometers, viz., "in the gallery outside the lantern in the air and shade," the averages of temperatures can only be regarded as roughly approximate. Thus it is difficult to see how, if the mean temperature of July be 76°·3 at Yedo, it is 86°·6 at Nagasaki.

The barometrical results can be regarded with nothing but astonishment. In the winter months the mean pressure decreases from the isobar of 30·30 inches, which skirts the south coast to the isobar of 30·10 inches, which passes through the centre of Japan, the lie of the isobars being from about W.S.W. to E.N.E. With this distribution of pressure, all meteorological observation would lead us to expect the prevailing winter winds of Japan to be south-westerly. The observations, on the contrary, show the prevailing winds to be northerly, in other words, they are in direct opposition to Buys Ballot's law of the winds. In summer the results are still more extraordinary. In these warm months pressure increases from the sea-coast inland. From Yedo westward to Sikok, a distance of about 350 miles, the lie of the isobars is from about W.S.W. to E.N.E., the highest isobar being the most northern. From this disposition of the isobars the laws established by meteorology would lead us to expect northerly winds. Observation, however, shows on this part of Japan the prevailing summer winds to be southerly. In this season, also, Buys Ballot's law of the winds is violated.

The discussion of this paper, therefore, teaches us that if we stand with our back to the wind in Japan, the low barometer is on our right, whilst everywhere else in the northern hemisphere from which we have observations, the low barometer is to our left.

But this is not all. In August the mean pressure at 32° and sea-level at Sagami (lat. N. 35°·8, long. E. 139°·41) is 29·371 inches, and in the same month at Yedo (lat. N. 35°·41, long. E. 139°·47) the mean pressure is 29·931 inches. These places, which are about thirty-three miles apart, have a difference in their mean atmospheric pressure for August of 0·560 inch, thus giving *a gradient in the mean pressure* in August of an inch in sixty miles. So far as we are aware, the steepest gradient yet noted at any time in this country was an inch in seventy-two miles during the Edinburgh hurricane of January 24, 1868—a gradient accompanied with a wind which threw down solid masonry, and horses as if they had been "jointless pieces of wood" (*Jour. Scot. Met. Soc.*, vol. ii. p. 177). Japan, however, presents us, in the above results, with an *average* summer gradient which, while it exceeds the *maximum* gradient attained during the Edinburgh hurricane, is accompanied only with delightful breezes as the prevailing summer winds of its coasts.

Most meteorologists will perhaps be inclined with us to let their notions regarding aërial movements remain undisturbed till it appears whether these results may not have sprung from extraordinarily constructed or disordered instruments, or even, it may be, clever manipulations.

While allowing that the author of the paper, who does not appear to be familiar with what has been done in meteorology in recent years, has discussed the materials before him with some ability, we can only express our regret that the Meteorological Committee have authorised the publication of the paper in its present shape, and included

[1] Observations taken at the Imperial Meteorological Observatory, Tokei, Japan, under the direction of C. A. McVean, Surveyor-in-Chief, No. 1 to 23.—"Contribution to the Meteorology of Japan," by Staff-Commander T. H. Tizard, H.M.S. *Challenger*. Published by the authority of the Meteorological Committee, Official No. 28.